Machinery Messages

Case history

TPM program saves cement p

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Tong Yang Cement (TYC) is a leader in the cement industry. It was the first Korean cement company, manufacturing cement since 1957. It operates the world's largest raw material mill, with a capacity of 560 tons per hour. TYC also has Korea's two largest cement kilns. Tong Yang Cement is a leader in computerization; all of its seven kilns are totally computer-controlled.

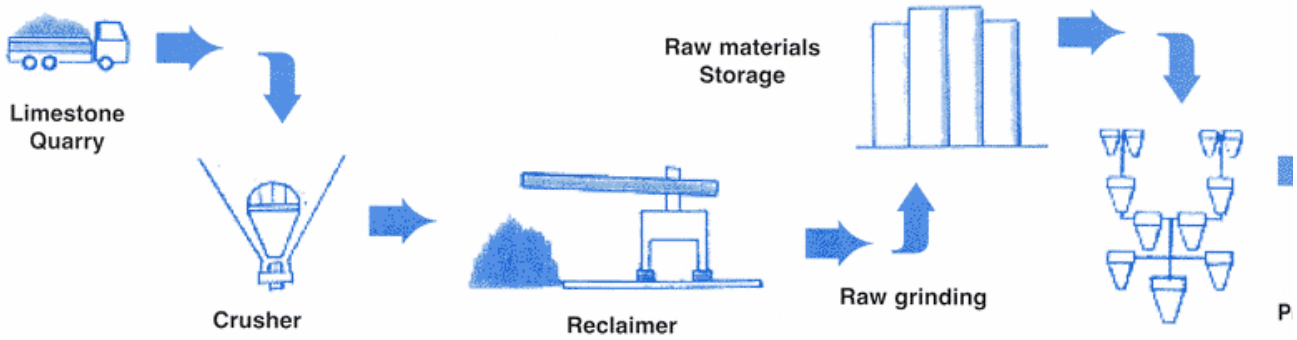
Tong Yang Cement is also a leader in computerized Total Productive Maintenance (TPM). The foundation of their TPM program is a computerized Bently Nevada Trendmaster® 2000 for Windows System. TYC was the first cement manufacturer to use Trendmaster 2000 for Windows. In the past year, the system reduced TYC's maintenance costs and unscheduled downtime, and saved the company $1,500,000.

The business problem

Tong Yang Cement cannot afford downtime. In Korea, TYC has thirty-one distribution centers and seven regional offices. Overseas, Tong Yang Cement has five subsidiaries and three representative offices. Last year, it sold 10 million metric tons (11 million short tons) of several different types of cement. Therefore, management thought it was essential to increase productivity by reducing plant downtime and the cost of maintaining plant machinery. In late 1993, TYC management asked the Mechanical Department to implement a Total Productive Maintenance program at the Samchuk Plant.

The Samchuk Cement Plant uses mostly small machines to manufacture cement in four main process lines (Figure 1). The machines, most of which are driven by 50 to 1000 horsepower motors, include compressors, crushers, reducers, pumps, blowers and fans. The Mechanical Department's TPM procedure required engineers to collect vibration data from each machine, to use that data to modify operation in a way that extended machine operating times, and to identify machines that were susceptible to failure.

Engineers had to rely on portable "walk-around" data collectors for this vital information, because vibration



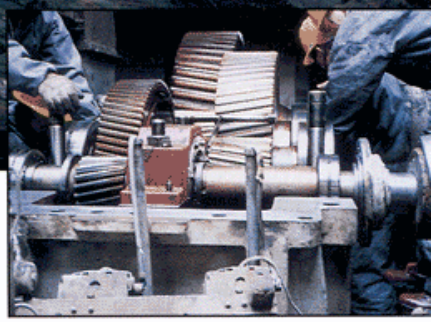
Cement is made primarily from a mixture of approximately 80% carbonate of lime, such as limestone, and 20% clay. At Tong Yang Cement's Samchuk Plant, cement is manufactured in four main process lines. Raw materials are pulverized and a limestone reclaimer, which stabilizes the mixture, is added. Materials are mixed in correct proportions and stored. In the combustion synthesis process, raw

Figu

lant $1,500,000 in first year

Operator using Trendmaster® 2000 for Windows Software.

The 6th kiln speed reducer.



Bearing side of 6th kiln speed reducer.

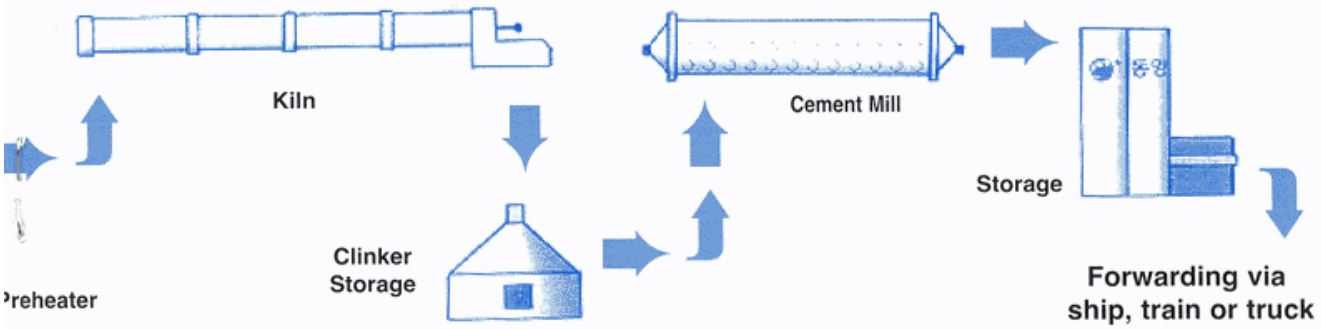
transducers were not installed on most machines. Tong Yang Cement's engineers found that it limited the TPM program's effectiveness, for four important reasons:

- Data collection was dangerous. While collecting data, TYC engineers had to stand next to operating machinery, which increased their risk of injury.
- The data was not accurate. A portable data collector requires absolute consistency each time a measurement is taken. Its hand-held transducer must be applied at the same location, angle and pressure each time data is collected. The Maintenance Department could not verify that each sample was collected in an identical manner.
- The data was too sparse, and could not be correlated with process data. The TPM program required so many machine measurements that, at best, engineers could take only one set of measurements per day. Important machine events were often missed, and the vibration data that was collected could not be correlated with process data.
- The data was too expensive. Daily data collection required too much of the engineers' valuable time.

After reevaluating its walkaround data collection system, Tong Yang Cement decided to install permanent sensors on 250 machines, and connect them to a system that would collect data automatically.

Trendmaster® 2000 for Windows

Tong Yang Cement's maintenance engineers evaluated online data collection systems, for effectiveness, reliability and cost. Bently Nevada's Trendmaster



materials are preheated and then burned in a large rotary kiln at approximately 1450° C (2642° F). A physical and chemical reaction creates balls known as "clinker." The clinker is cooled, ground to a fine powder, and gypsum is added to control the speed of setting. Finished product is stored in silos. The cement is shipped by truck, ship or train, in a bulk state or packaged in bags.

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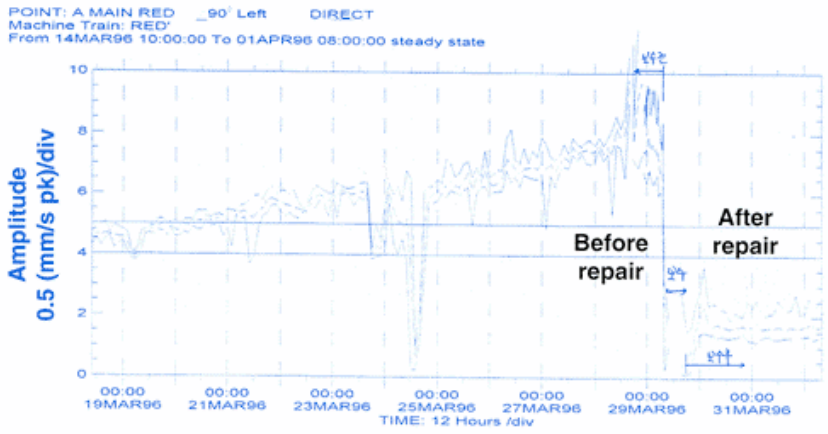

Figure 2
Trendmaster 2000 unfiltered trend plot, showing overall vibration had increased.

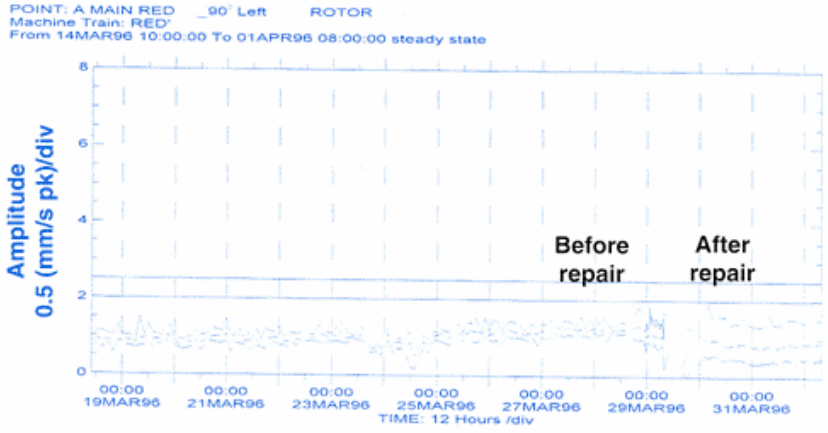

Figure 3
Trend plot of data filtered to rotor speed, showing no vibration increase.

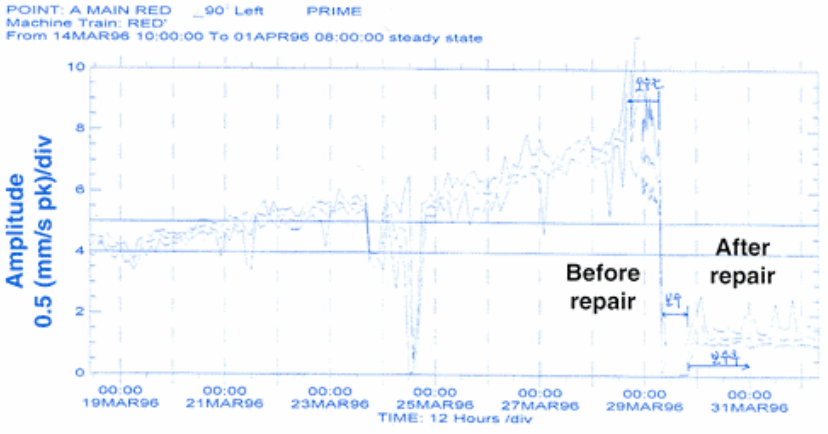

Figure 4
Prime Spike trend plot, showing an increase in vibration.

2000 for Windows was one of these systems. Trendmaster 2000 for Windows had not previously been used in the cement industry, so TYC engineers evaluated it carefully. They first studied its capabilities, and how it might be applied to their machinery. Next, they examined the performance of Trendmaster 2000 in other plants in the Republic of Korea. Their extensive investigation convinced them that the Trendmaster 2000 System was the right solution.

Tong Yang Cement installed Trendmaster 2000 for Windows at the Samchuk plant. In August 1995, TYC finished installing 146 accelerometers and 50 proximity transducers on machines in the 6th and 7th kiln areas. The system was networked, so both operators and maintenance engineers could view its data. Engineers immediately began receiving more timely, consistent and reliable data. Samchuk's TPM program became much more effective.

Trendmaster 2000 is a field-proven, permanently-installed data acquisition system. It uses lower-cost components and an innovative data acquisition scheme, which reduces installation costs. All field circuitry is powered by the system, so additional power connections are not required. Trendmaster 2000 for Windows is reliable and plots data in the formats that are essential for identifying problem machines and diagnosing their faults.

With Trendmaster 2000, plant personnel can now view current condition information and accurate, detailed historical information on their computer screens. Process and machinery condition data can be displayed and correlated on operators' computer screens, so they can make better-informed decisions.

Automatic data collection, using mounted probes, eliminates the recurring cost of manual data collection. Not only is money saved by using automatic data collection, but data is far more accurate.

Early fault detection avoids downtime

In March 1996, Trendmaster 2000 for Windows alerted engineers to a problem on the first stage of the 6th kiln's main

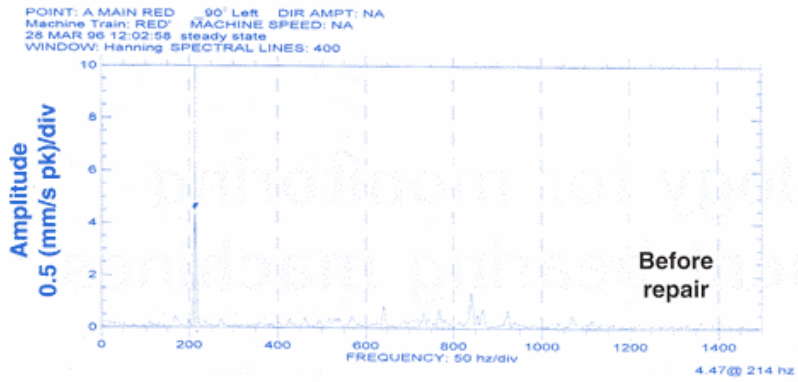

Figure 5
Spectrum plot which verified the Prime Spike data in Figure 4.

speed reducer. The speed reducer is a gearbox which reduces the rotational speed of the motor that drives the kiln. The speed reducer has rolling element bearings and is driven by a 960 hp motor. It is monitored by four accelerometers, two on the inboard side of the motor and two on the pinion side of the reducer. A Trendmaster 2000 for Windows unfiltered trend plot showed that overall vibration had increased (Figure 2). Engineers next viewed two filtered trend plots, to further isolate the problem. The first plot was of data filtered to the rotor vibration region (Figure 3). It showed no vibration increase. The second plot was a Prime Spike trend plot. Prime Spike plots, created by Trendmaster 2000 for Windows, emphasize flaws in the inner or outer races of rolling element bearings. The Prime Spike trend plot (Figure 4) showed an increase in vibration similar to the unfiltered trend plot. TYC's engineers suspected that bearing failure was imminent.

Plant engineers closely monitored the machine. A week later (Figure 2, 28MAR96), vibration levels increased again. Engineers used Trendmaster 2000 for Windows to generate a frequency spectrum plot (Figure 5), which verified the Prime Spike data. It showed a large, bearing-related 214 Hz frequency component, which was within the Prime Spike frequency region. The machine was shut down and inspected. Significant bearing wear was found (Figure 6).

Figure 6
Failed components showing bearing wear.

The bearing was replaced, and the reducer was returned to service. Its vibration returned to normal (Figures 2 and 4, 29MAR96).

Trendmaster 2000 for Windows helped plant engineers identify the problem before the machine failed, so they could order a replacement part and schedule maintenance. Plant engineers estimate that this advance notice saved 24 hours of unscheduled downtime. The reducer produces 308 tons of clinker per hour. At $60 per ton, TYC estimated that Trendmaster 2000 for Windows helped save $440,000 worth of production that would otherwise have been lost.

In the first year it was installed, Trendmaster 2000 for Windows was also instrumental in these machine saves:

- Cooler hammer crusher, driven by a 180 hp motor.
- Dosing bucket elevator reducer, driven by a 120 hp motor.
- Cooler motor, driven by a 240 hp motor.
- Cooler fan, driven by a 240 hp motor.

These four machine saves avoided 80 hours of unscheduled downtime, saving the plant approximately $1,500,000.

Evaluation and expansion

Mr. Hyung-Mo Choi, Manager of Tong Yang Cement's Mechanical Department, recently evaluated the system. He says,

"Our vision of Total Productive Maintenance is of a system that delivers spare parts in a timely manner and reduces repair times. We selected Trendmaster 2000 for Windows because the information it provides supports our vision of TPM. We are fully convinced that the system is exactly what we needed. We have obtained incremental increases in our plant's productivity and availability through early detection of machinery problems. Trendmaster 2000 for Windows is helping us realize our vision." He adds, *"We plan to extend Trendmaster 2000, to not only the kiln machinery, but also to cement mill units #2 and #7."* Mr. Choi also said that, although the first year after installation was a learning and evaluation period, Tong Yang Cement's overall efficiency has steadily increased.

Tong Yang Cement is currently expanding the system. They have already added 200 new measurement points, in the 4th and 5th kiln areas. In early 1997, they will add the 1st, 2nd and 3rd kiln areas to the system.

As TYC began realizing tangible benefits from the Trendmaster 2000 system, they became more confident in their engineers' ability to detect machinery problems at an early stage of development. In the increasingly competitive cement business, where safe and efficient plant operation are key factors, Tong Yang Cement has gained a competitive advantage from its Trendmaster 2000 for Windows System.■